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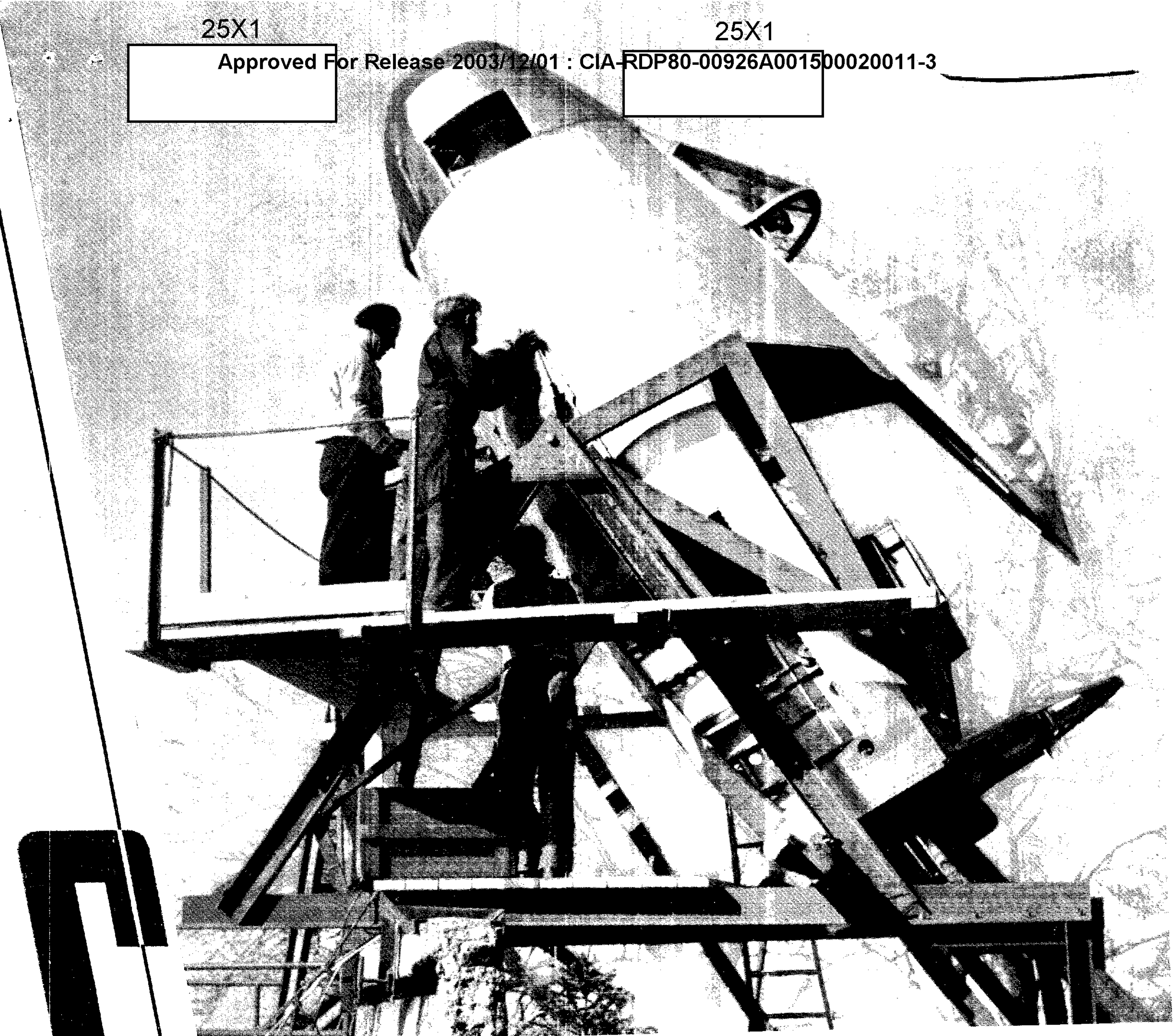

SAAB SONICS

30

NUMBER 7

JULY—SEPTEMBER 1949

SAAB SONICS

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No. 7 JULY—SEPTEMBER 1949

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Cover picture: A moon rocket? No, merely the front fuselage of the jet fighter Saab-29 during shooting tests at high elevation (Saab Photo: R. Danielsson)

Classification summary for the technical articles is to be found on the third page of the cover

Printed in Sweden by Oscar Isacsons Boktryckeri AB,

ROCKETS ON THE SAAB-18

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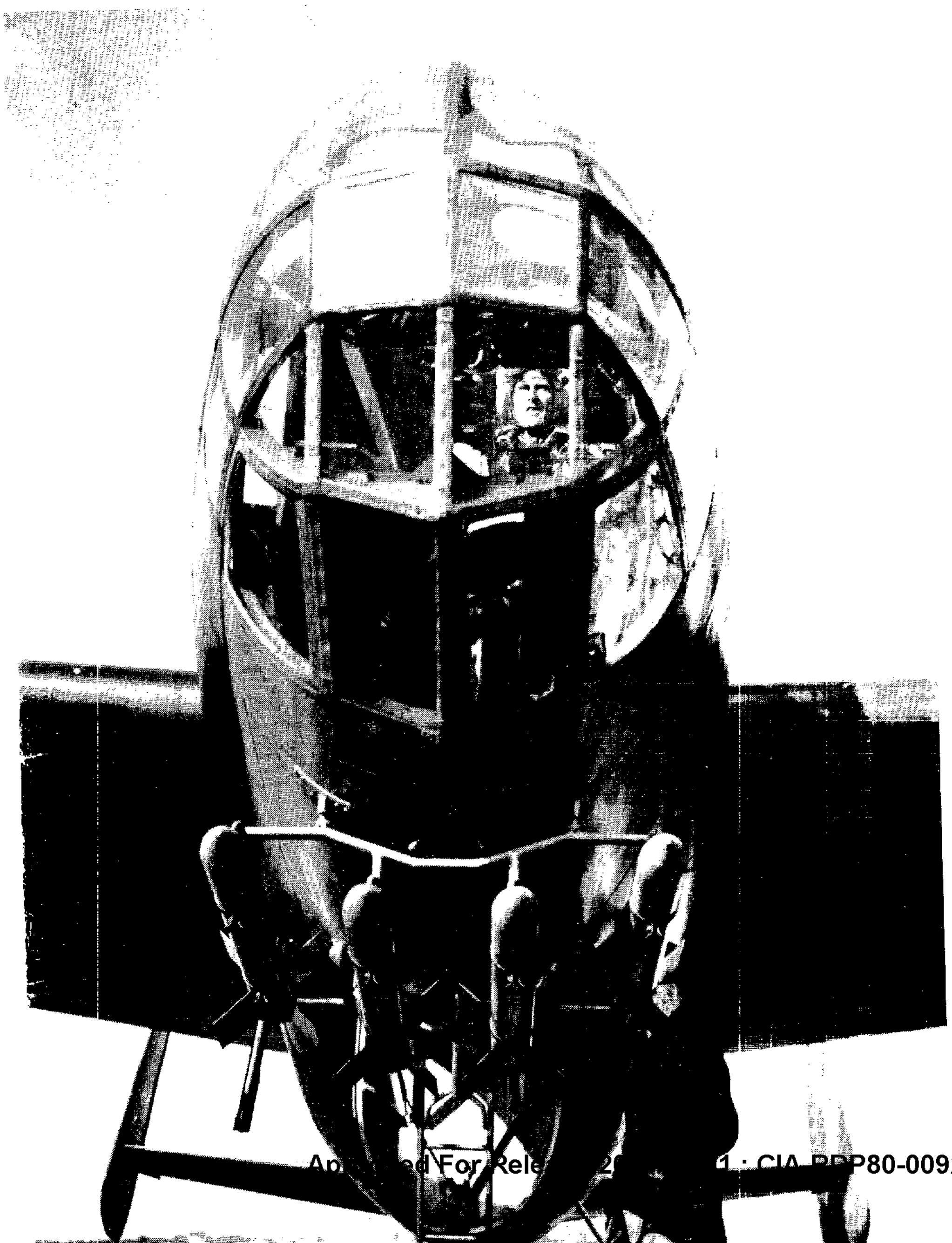


The extensive Swedish Air Force manoeuvres held in the spring in which more than 300 aircraft took part provided the first comprehensive test for attack-bombers, and the Saab-18 in particular was frequently in action. At the top a Saab-18B is seen during a rocket attack — thick black smoke marks the path of the projectile. The frog perspective on the left shows the rocket installation under the Saab-18B's characteristic plexiglass nose (Photo: Text & Bilder, Stockholm)

The Flight Safety Service of Civil Aviation

Fig. 1. A view over the aerodrome and its surroundings is obtained from the control tower. The illustrations shows the new control tower at Bromma Airport, Stockholm

The general description of the Swedish Board of Civil Aviation, published in the previous issue of "Saab Sonics" is supplemented here by a more detailed account of the flight safety service which is carried on under the supervision of the Board of Civil Aviation. The article is written by Traffic Inspector J. G. Karlsson.

In accordance with the convention relating to international civil aviation, known as the Chicago Convention, it is incumbent upon each signatory state to provide the ground organization and service necessary for carrying on international aviation.

One of the most important duties for the respective states consists in the establishment and operation of a flight safety service which may be understood to include air traffic control, communication and meteorological service.

In Sweden the flight safety service is so subdivided that the Board of Civil Aviation is responsible for the air traffic control, The Board of Telegraphs for the main part of the communication service and SMHI (The State Meteorological and Hydrological Institute) for the meteorological service for flights. The traffic division of the Aviation Board is responsible for coordinating the activities of the different branches of the flight safety service.

Air Traffic Control

The primary task of the air traffic control service is to promote the safe, orderly and expeditious movement of air traffic. This task, which may be of a very complicated nature where heavy traffic is concerned, makes strenuous demands on the person responsible for carrying it out — the air traffic controller.

The need for air traffic control is most obvious, of course, in and around large aerodromes. Here the traffic is supervised and directed by the aerodrome traffic controller who is stationed in the control tower. For this purpose he can avail himself of directional light signals in order to transmit directions and clearances to the aircraft on the manoeuvring area and in the vicinity of the aerodrome (see Fig. 2). At the present day, however, connection between the controller and the aircraft is being maintained to an increasing extent by means of radio-telephony which permits more rapid and reliable direction of the traffic.

For air traffic control purposes a distinction is made between flight carried out under VFR-conditions (VFR — Visual Flight Rules) and IFR-conditions (IFR — Instrument Flight Rules), that is to say, flights taking place under favourable and less favourable weather condi-

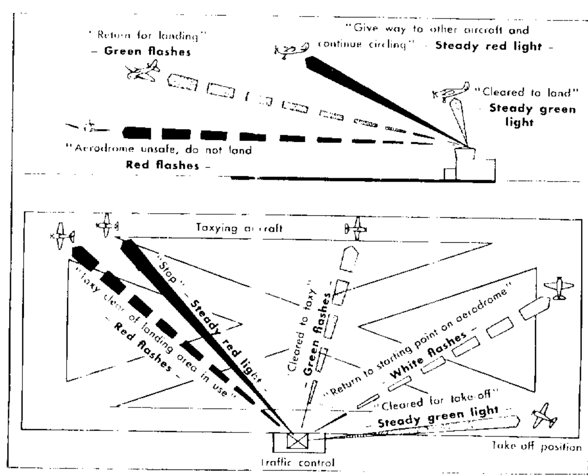


Fig. 2. Directional light signals for aerodrome control

tions respectively. The limit values between VFR- and IFR-conditions will be seen from the following table.

	Within the control zone. Outside the control zone when the flight altitude is 700 ft. (200 m) or more	Outside the control zone when the flight altitude is less than 700 ft. (200 m)
Visibility	3 miles (5 km)	1 mile (1.5 km)
Distance from clouds	500 ft. (150 m) vertically 2000 ft. (600 m) horizontally	clear of clouds

Under VFR-conditions air traffic control only takes place at the aerodromes for the purpose of expediting the taking off and landing of planes. Here the responsibility for avoiding collisions devolves upon the pilots themselves. Under IFR-conditions, on the other hand, where in most cases it is not possible for the pilots to observe a safe "separation" between planes, the responsibility for this separation is allocated to the controller. This form of air traffic control is, however, at present limited to IFR-flights within the control zones and control areas. The extent of the control zones and control areas may be seen from Fig. 4.

Traffic Inspector J. G. Karlsson

The control of IFR-flights is based on the principle that data relating to the proposed flight, combined in the form of a "flight plan", are submitted to the air traffic controller for approval. The flight plan includes all particulars concerning the flight which are of importance for control purposes, such as routes of flight, flight altitudes and times, the radio and navigational equipment carried, the amount of fuel on board, alternative aerodromes, etc.

The flight plan is examined with due consideration to other IFR-flights announced, and carefully checked to ensure that there is a sufficient vertical, longitudinal or lateral separation between the different flights. As a general rule for determining the separation within the airways the distance, expressed in flying time between two planes at the same altitude, should be at least 15 mins. If this separation in time

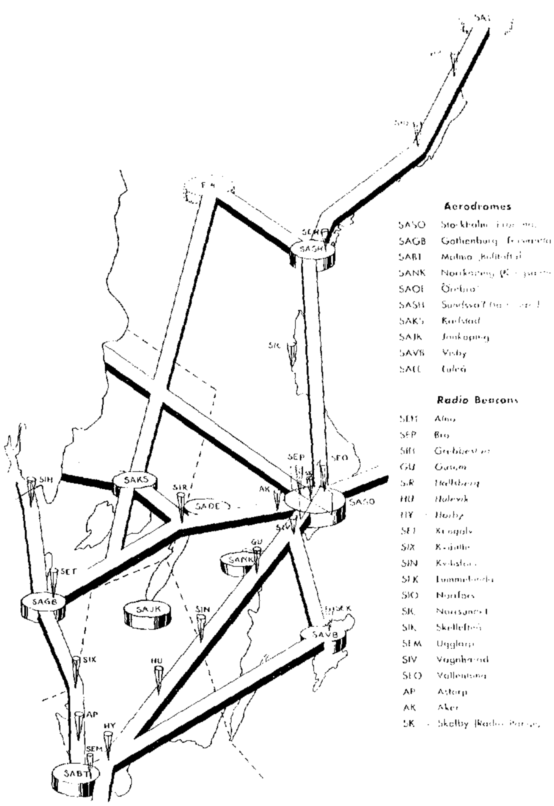


Fig. 3. The Swedish Airways

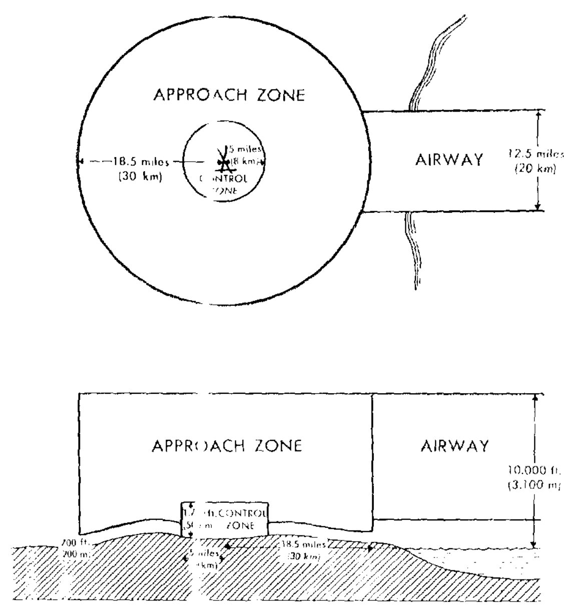


Fig. 4. Extension of the control areas and control zones

is reduced, the vertical separation should be at least 1000 ft. (300 m).

No deviations from an approved flight plan must be made in flight without the controller's permission.

Aircraft flying under IFR-conditions within a control zone or control area must maintain radio contact with the air traffic control during the whole time and must report their position at predetermined reporting points to enable the controller to follow the progress of the flight.

With respect to its activities, the air traffic control handling IFR-flights is organized for area control and approach control. Generally speaking, the area control handles flights in the airways within its own flight information region whilst the approach control handles flights into or out of the approach zone of the aerodrome.

Sweden has three flight information regions: Stockholm, Gothenburg and Malmö, each with its area control at Bromma, Torslanda and Bulltofta respectively. Aerodrome control which also functions as approach control is installed at the following aerodromes: Bromma, Torslanda, Bulltofta, Norrköping-Kungsängen, Sundsvall/Härnösand, Karlstad and Visby, and to a limited extent on the Jönköping and Örebro aerodromes.

Communication Service

To enable the system employed for the air traffic control to function faultlessly, rapid and reliable means of communication by radio and wire must be available.

Communication between the air traffic control and the aircraft within the control and approach

Fig. 5. The radio telegraphist at work

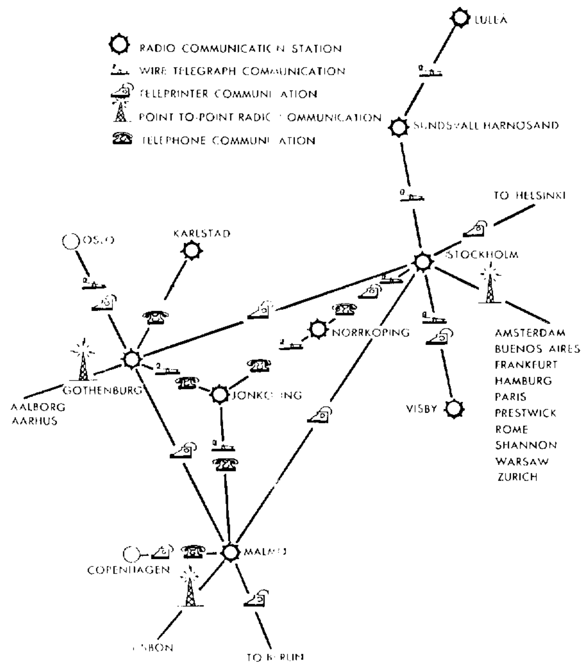


Fig. 6. The fixed communication network for civil aviation

zones is usually carried on by radio telephony. Most air traffic control services are now provided with both HF (high frequency) and VHF (very high frequency) radio equipments.

Aircraft in the airways maintain radio communication with the area control by means of radio telegraphy via the ground communication stations. These communication stations are located at Bromma, Torslanda and Bulltofta in conjunction with the area control. In addition, communication stations are installed at the airports of Sundsvall/Härnösand, Visby, Karlstad and Jönköping. Between these last-mentioned stations and the area controls, messages are transmitted by rapid telephone- or wire telegraph communications.

The communication station at Bromma not only maintains contact with aircraft within the Stockholm flight information region but also with planes out in other parts of the world. Thanks to these communications the operating companies can follow up its planes out on their routes and transmit any direction that may be necessary.

Moreover, it falls to the lot of the communication stations to assist aircraft in navigation by radio direction-finding, which implies that the radio stations determine the positions of the aircraft and direct them when approaching and landing. Radio direction-finding from the ground is, however, a method which is being abandoned to an increasing extent in short- and medium distance navigation. This navigation can now be performed by aid of the radio beacons installed along the airways and at the aerodromes. When approaching and landing, the plane is directed by special radio beacons or a system of radio beacons. The landing beacon system adopted for international use is the ILS (= Instrument Landing System) which by means of an instrument gives the pilot an indication of the plane's position in relation to the path through the air which should normally be followed in landing.

For communication between the Swedish aerodromes themselves and those of adjoining countries a network of wire communications has been installed specially for aviation. These wire communications consist of telephone-, telegraph- and teleprinter connections (see Fig. 6).

The two first-mentioned forms are mainly intended for short messages to and from aircraft in the air and urgent messages between air traffic controls concerning the air traffic. The teleprinter connections are employed for messages where the need for immediate transmission is not so urgent, as for example in the case of flight plans, departure and arrival messages, weather messages etc.

Finally, it may be noted that point-to-point radio communications are established between some Swedish communication stations and a number of distant places falling within the network of the Swedish air routes, such as Lisbon, Rome, Buenos Aires and others (see Fig. 6).

Flight Meteorological Service

To enable a pilot to plan a flight and carry it out safely he must have information at his disposal concerning the prevailing and predicted weather conditions over the route in question.

This information is supplied by the flight meteorological services, the most comprehensive of which is located at Bromma Airport. Main meteorological stations with authority to issue weather forecasts are also provided at Torslanda and Bulltofta. The remainder are known as dependent meteorological stations which obtain their forecasts from the main stations.

Fig. 7. A radio sonde is sent up for meteorological observations in the high altitudes

Dependent stations of this kind are to be found at the aerodromes in Norrköping-Kungsängen, Visby, Sundsvall/Härnösand and Karlstad.

Meteorological observations are usually made at all stations every half-hour. These, with the numerous observations taken in different parts of the country and the information coming in from other countries, provide the material for the forecasts concerning flying weather conditions prepared by the main meteorological stations. These forecasts are based on the meteorologist's analysis of the synoptic weather maps which are drawn up every three hours.

Meteorological information relating to most parts of Europe can be obtained at all meteorological stations. In addition, the station at Bromma include- a special section for Atlantic flights.

Aircraft in the air can obtain information regarding present and forecast weather conditions either by a request through the radio communication station or by listening to the scheduled meteorological broadcasts from the communication stations.

Some Aspects of the Design of Swedish Military Aircraft

Mr. Lars Brising, chief engineer of design and development and chief designer of the jet fighter Saab-29, has previously dealt with the inception of military aircraft in an article published in the Swedish "Teknisk Tidskrift". As the subject is one likely to interest readers of "Saab Sonics" also, the article is reproduced here in its original form.

The time is now long past in which the designing of a military aircraft could be said to represent the creation of a single individual. Nowadays the work has assumed such proportions that it must be regarded as team work, a task for a large and well-organized group of engineers possessing various qualifications. This group, moreover, is required to collaborate on an extensive scale with the military authorities, research institutions and experts of different kinds in order that all the resources and experience available may be combined to produce a result which can hold its own in keen international competition. The design of a military aircraft is, therefore, an organization problem.

Organization

The various stages in the production of an aircraft may be said to comprise: project work, prototype design, prototype testing and design for production. It is desirable that all these stages should be arranged and carried out by one and the same department, a design department in the wider sense of the term.

The lines on which a design department of this kind is organized at the Saab Works are illustrated in a general form in the diagram

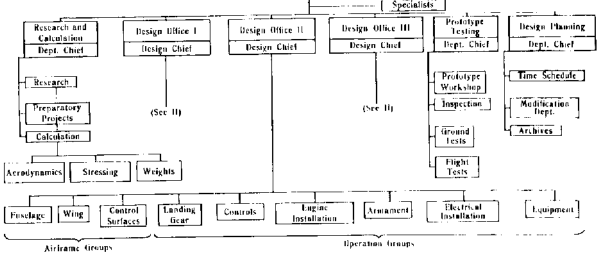


Fig. 1. Plan for the organization of a design department

Fig. 1. Thus, in addition to the design offices themselves, special sections are included for planning, research work, calculations and testing. Only one or a very few types of aircraft are allotted to the actual design sections and these sections represent the coordinating centres for the particular types in question. On the other hand, the special departments work simultaneously on all types of aircraft in hand, at the different stages and carry on a certain sub-division and specialization amongst themselves with respect to the different types. An attempt has thus been made to combine organization on a wide front (specialized technical knowledge) and a deep front (knowledge of special types) and this solution, similarly to all other organization planning, is naturally accompanied by advantages and drawbacks. Generally speaking, however, it is probably typical for the modern aviation industry.

The actual engineering work associated with the design of a medium-size modern military aircraft occupies a working time corresponding to about half-a-million working hours and the major part of this work must usually be performed in the course of 3–4 years at the most if the aircraft is to be up-to-date on its completion. The temporary loads placed on the different departments during this period are very uneven. Consequently, an endeavour is made to carry on the development of a suitable number of aircraft types simultaneously, the work being spaced in such a way that the peaks and troughs largely counterbalance one another. The appearance of such a scheme in principle is shown diagrammatically in the time schedule, Fig. 2. The equalization of the loading thus

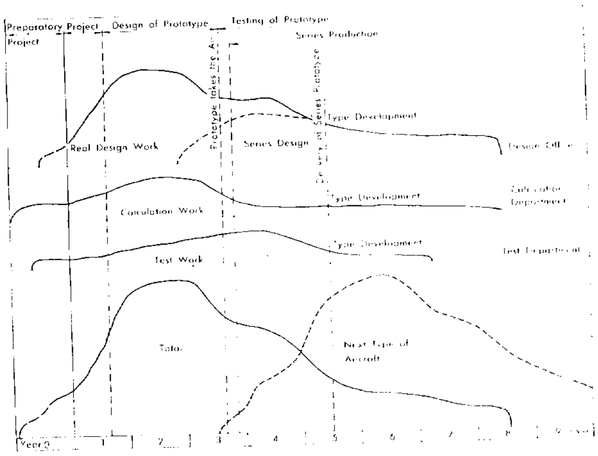


Fig. 2. Load diagram for a design department

effected will then constitute the determining factor for the total personnel required in the design department, 300 400 men, and this represents the lowest limit if the work of designing is to be carried on efficiently. If the average load is lower on account of the initiation of new designs at longer intervals, it would be necessary to move the technical staff backwards and forwards from one department to another. This can only be done to a limited extent without causing a deterioration in efficiency since modern aircraft design calls for a high degree of specialization in most branches of the work.

Amongst the Great Powers, which have a number of aircraft firms at their disposal, it may be possible to keep a qualified personnel constantly employed by maintaining a periodic exchange between these firms and reducing the scope of each designing department somewhat in this manner. This is not possible in Sweden at the present time, however.

Planning

The purpose of planning is to determine the main lines to be followed in the subsequent work of design, in collaboration with the customer (The Swedish Air Force). After studying the research results, the rough calculations and the sketch plans, a type specification is produced in which all the important qualities of the aircraft to be constructed are indicated as clearly as possible. In this connection the customer's requirements regarding performance or the like frequently assume the character of a prediction of international military aircraft development during the coming 4 5 years, that is to say, the requirements cannot be based exclusively on technical calculations but must largely take into account observed lines of development. The designer must be able to convince himself and others that he can keep up with the race and even maintain a slight lead. To enable him to do this he is obliged at times to suggest unconventional technical solutions which seldom meet with appreciation.

In this connection it will not be out of place to discuss the term "development". Insofar as one may regard the results of research and other aeronautical progress as a continuous stream advancing steadily with time, a new type of aircraft which must be completed within a given period should always be better and more up-to-date, the later this excellent stream of experience is drawn upon with the object of producing a definite design. On the other hand, it might be said that the quality of an aircraft type should be in proportion to the amount of time and work expended on the problems related to this special type, and consequently it is desirable to start work on the design of the type selected at as early a stage as possible with reference to the proposed delivery date. The ultimate choice is, of course, a matter of judgment. Occasionally, one comes across particulars of new and sensational types of planes in America which have been designed and built in 144 days, and so on. On the other hand, it cannot be denied that the majority of the most successful types of planes are the fruit of a relatively long period of development work. All the planes that played a really decisive part in the late world war had already been projected as far as their basic type was concerned, and even tested in flight to a large extent, before the outbreak of war.

The development of engine types is perhaps the most significant feature in this respect. In

The author, Mr. Lars Brising

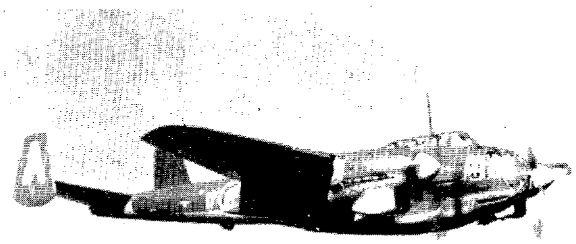


Fig. 3. Saab-T18B is the second major modification of a type the plans for which were put in hand in 1938 39. With its present armament and performance it may still be considered a relatively up-to-date aircraft of its class

view of the enormous influence exercised by the engine output on the performance of the aircraft, it may be taken as a practical rule to proceed with the work of design on the type selected as rapidly as possible as soon as a given available type of engine with a suitable output has been decided on. The aircraft type in question can then be made to give an appropriate performance in all circumstances for some time ahead, and in the event of later improvements being effected in the engine, it will as a rule be possible to take advantage of the increased output by introducing insignificant changes in the aircraft type. From this point of view it has always been a weakness of Swedish-built planes that we have no home-produced engine designs available. The engines built here under licence are usually on the way to becoming obsolete by the time they have been put into production and it has scarcely been possible hitherto to undertake any continuous development work with a view to modernizing these types.

Preparation of a Time Schedule

One important matter which should also be dealt with during planning is the preparation of a time schedule for the progressive work of design. It should be possible on the basis of the project layouts to calculate the total volume of work which will be necessary and the intervals of time at which the designs for different parts should be completed and strength calculations carried out. These time intervals should simply be based on the sequence of assembly in the experimental workshop. It is necessary, therefore, even while the project design is in progress to prepare a complete assembly scheme, a scheme which covers a period of about half-a-year. From these fixed assembly times it is possible to calculate backwards the length of time required to produce each part, from which a delivery plan for the drawings is arranged. This plan usually drives the designer to despair, since the plan indicates that a beginning should be made with the delivery of data for all castings, forgings and rubber details which are scattered throughout all parts of the plane, whilst the drawings of the associated assemblies are to be delivered several months later. This reversed order is necessitated by the delivery times of the Swedish mechanical industry in recent years, since the parts in question must be produced by outside firms and require a much longer time for their production than Saab's own products.

The time schedule also covers all aerodynamic, strength and functional tests which certain parts have to undergo before the design can be approved. With the capacity permissible from an economic point of view it is not possible as a rule to carry out all such tests before the drawings are sent out to the workshops. The best one can hope for is that the results of the tests will be available in reasonably good time before test flights are begun. Should these results be found somewhat unsatisfactory, it will become necessary to improvise some rapid changes in the design which is not always an easy matter.

In America in particular the testing technique has been carried to such lengths in the aeroplane industry that new designs can be constructed experimentally and tested in time to allow the results to be actually utilized in the design work. They have possibly been used on occasion to an exaggerated extent. Theoretical consideration of the problems may sometimes be neglected in favour of the empirical "cut and try" method. Under the conditions prevailing in Sweden and with our limited resources it is necessary to adopt a middle course which is as favourable as possible. It should be noted, however, that even theoretical considerations may entail a large capacity and heavy costs if the results are to be obtained in good time.

Design particulars

The demands made with respect to Swedish military aircraft designs are, generally speaking, no more severe than those prescribed in England, for example (our difficulties consist primarily in maintaining this high standard with appreciably smaller resources). Swedish winter conditions exercise an astonishingly small influence on the design shape, and the explanation of this lies in the fact that the problem of low temperatures has to be dealt with in milder climates also — for high altitudes. Moreover, with a view to the foreign types of aircraft it employs, the Swedish Air Force has been obliged to develop such methods for ground service that "ordinary" planes can be serviced even under severe winter conditions.

On the other hand, the fact that Swedish airfields are usually small and in most cases have not yet permanent runways, has set its mark on all types of Swedish planes. It has been necessary to keep wing loading and wheel pressures within moderate dimensions in order to permit take-off and landing on the muddy fields and, needless to say, this has not been possible without making sacrifices with respect to performance in other respects. With regard to the demands made in general respecting safety, these are very onerous in our country. The Swedish aeroplane industry can bear witness that the Royal Swedish Air Force never makes any concessions in demands relating to constructional safety, even when these entail considerable sacrifices in time and performance. That crashes nevertheless occur as the result of constructional errors is due to the enforced rapid pace in the technical development of flight and also — unfortunately — to the human imperfections of designers.

The design inspection exercised by the Air Force in this country is extremely thorough. The aim kept in view is, therefore, that the

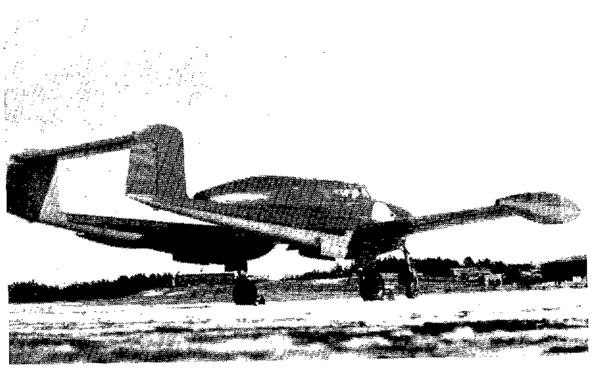


Fig. 4. The basic type with pusher propeller for the Saab-21R was designed in 1941 and was possibly ahead of its time at that period. Its introduction in service was delayed by certain minor difficulties, and the development period passed by. The former lead has now been nearly regained by the relatively successful modification with jet propulsion

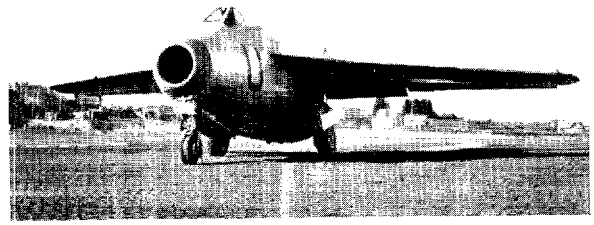


Fig. 5. The Saab-J29 was projected at the beginning of 1946 and was flown on the 1st September 1948

essential constructional principles and all important installations shall meet with the approval of the various representatives of the authorities already at the design stage. This is unquestionably a desirable end, but it can scarcely fail to have a hampering effect on the work of the designers. Moreover, the practice is not generally adopted on such an extensive scale abroad, where the aircraft manufacturer usually hands over the plane to the customer as a finished product, whereupon the type is tested and judged in its completed form. By this means the designer is in a better position to ensure that the plane, regarded as a single unit, will finally represent an effective weapon, which is more difficult to arrange when each specialist must have all his demands satisfied at the outset. In the last resort, the best arrangement will depend upon the competence and experience of the different parties, and nothing further need be said on this somewhat delicate topic.

A Specialized or Versatile Type

The military aeroplane has been developing in the direction of constantly increasing specialization. In America, for example, a distinction is drawn between three to four main types of fighter planes: interceptors, penetration fighters, "all-weather" fighters and sometimes special night fighters. In addition, different forms of design are adopted depending upon whether the planes are to be land based or carrier based; more recently, parasite fighters have been added to the list, these being carried on board the largest bombers. It lies in the nature of things that a Swedish aeroplane industry cannot produce so many specialities but is obliged to concentrate on the most important main types which can be built in adequately large series. Even when a type of this kind has been planned from the outset, however, a desire will be expressed sooner or later for a modified type of plane for some novel purpose: the reconnaissance plane P 7 (Saab-S17) has become the dive bomber Saab-B17, the bomber Saab-B18 has become the reconnaissance plane Saab-S18 and the torpedo plane Saab-T18, the fighter Saab-J21 has become the attacker Saab-A21, and so on.

Objections to these changes are seldom raised on the part of the designers; on the contrary, they are only too willing to discover new possibilities of development: and the practice of employing one and the same basic type for numerous purposes possesses numerous advantages. Unfortunately, however, it may be accompanied by the drawback that the series of the different versions produced is disproportionately small, and thus two of the greatest weaknesses in Swedish aircraft construction are further aggravated. In this respect it has frequently been observed that foreign types are more carefully designed with a view to mass production and field service based on experience. Each version of these types may possibly have been produced and tested under service conditions by the thousand, and this is the obvious pre-requisite for exhaustive design work.

Design for production

Series produced aircraft must, as a rule, be built in accordance with drawings which have been revised more or less one hundred per cent in relation to the prototype drawings. It is chiefly a question here of alterations necessitated by manufacturing methods, and only to a minor extent to changes due to the testing of the prototype. However, for reasons of time, series construction must often be begun long before the first prototype has been flown, and what is even more questionable, their first phase must in many cases be completed before the flight tests have been concluded (see Fig. 2). This is a hazardous procedure which has been enforced by the demand that the latest types should be incorporated in the flight squadrons as soon as possible — a war is not won with a single prototype plane and no one can say when there will be a war. It is inevitable, therefore, that the first prototypes of a series are impaired by faults which stand in inverse relation to the tests carried out. Only by gradual degrees during the development of the type, which is carried on simultaneously with series production, is it possible to remove all the constructional faults which are referred to under the somewhat hackneyed title of "infantile diseases." In order to find a partial remedy for these troubles the practice has recently been adopted of providing a number of prototype planes of each type so that testing can be carried to the greatest possible lengths in the short time available. In this way it is hoped to remedy the regrettable fact that it has barely been possible to cure the "infantile diseases" before the brief series production ceases.

Possibilities of Swedish Aircraft Design

From the point of view of design we possess the advantage in this country of being able to count upon the services of a technical staff with a good all-round training. The sympathetic understanding of the State authorities for aeronautical research work is also increasing in a gratifying manner although the grants made to this end, when reckoned in Swedish crowns scarcely amount to the corresponding American figure reckoned in megabucks*). The high quality of the Swedish mechanical industry has frequently been mentioned, and this lends support to good designs. It is, perhaps, as well not to place undue reliance on this fact, however, since developments in the same direction abroad are not exactly at a standstill.

The difficulty of attaining results in sufficiently short time must be regarded as the chief difficulty hitherto. Satisfactory projects have exhibited an unfortunate tendency to become obsolete to a disproportionate extent before they have reached the full series production stage.

In order to force on development work it is not merely sufficient to increase the capacity in certain directions, an increase which will probably soon demand an extension of sales beyond the Swedish market in order to render it an economic possibility. It is also necessary to obtain satisfactory coordination between all authorities concerned with the inception of the aircraft, a practical division of work and responsibility between the customer and manufacturer. It is further essential that the time schedule for an aeroplane type should be adhered to by everyone whatever the cost which, however, will certainly be relatively low in comparison with the value of the more rapid results obtained.

*) 1 megabuck = 1 million dollars (currency unit for atomic research workers and others).

Editorial

The Vice President of ABA (Swedish Air Lines), Mr. Karl Lignell, has issued a report setting out his views concerning the Scandia, formed during the three winter months in which the plane was placed at ABA's disposal for practical tests.

ABA's pilots have expressed the greatest satisfaction with the Scandia's flying qualities, says Mr. Lignell, particularly the stalling qualities, and the single-engine performance was found to be very good. The practical equipment of the pilot's compartment has facilitated operation in a high degree, whilst the carefully thought-out constructional units have appreciably simplified the work of serviceing.

From the point of view of operating economy the Scandia will show very favourable results, which may be seen from the fact that the plane can produce double the number of ton-kilometres per flying hour compared with the DC-3, whilst the maintenance costs for the Scandia will not exceed those of the DC-3 by more than 20—25 %.

Mr. Lignell's report concludes with the statement that the general impression made by the plane is particularly favourable and that under practical service conditions the Scandia was found to fulfil the stringent demands respecting technical standards, flying qualities and flying safety which ABA makes of its aircraft.

Four-bladed Hydromatic propellers of an entirely novel type have been supplied to Saab by the American propeller factory Hamilton Standard Propellers. The propellers have been specially designed for the Scandia and are intended for use with the new Pratt & Whitney Twin Wasp engine R-2180. They have blade profiles giving the maximum thrust coefficient ever employed for a Hamilton Standard-propeller, which allow a very high thrust at starting, notwithstanding the relatively small propeller diameter.

Further advantages are found in the high oil pressure for feathering the blades — advantageous at low external temperatures — and an effective electrical deiceing system.

A new experimental version of the Saab Safir was shown publicly in the course of a demonstration at Bromma Airport, Stockholm, on the 29th May held in connection with ABA's 25th Jubilee. The new Safir — known as Saab-91B — which already in January had been flight-tested, differs from its predecessors in the provision of a sonsiderably more powerful engine — a six-cylinder American Lycoming O-435-A with a take-off output of 190 HP.

As anticipated, the already excellent performance of the Safir has been improved appreciably by the Lycoming installation. Thus, the flight tests show an increase of top speed to 177 m. p. h. (285 km/h) whilst the cruising speed has risen to 155 m. p. h. (250 km/h). Notwithstanding the fact that a higher all-up weight than before is now permissible — 2370 lbs. (1075 kg) as compared with 2200 lbs. (995 kg) — the starting properties have likewise been improved, inasmuch as the take-off run has been reduced to 510 ft. (155 m) and the rate of climb increased to 1180 ft./min. (360 m/min.).

An analysis of labour capacity carried out on an extensive scale has been in progress at the Saab Works during the month of May. The committee for physiological labour research is responsible for the investigation which is being directed by an American specialist for labour analyses, Professor Bert Hanman, who in his system groups the different forms of work according to the physical qualifications of the workers. In accordance with this system the right man can be allocated to the right job, both when first engaged and when rearranging the work. Since 1946 Saab has adopted a method of its own on somewhat similar lines but less detailed than the American method. At the conclusion of the investigation on the 12th June some 500 different forms of work had been analysed.

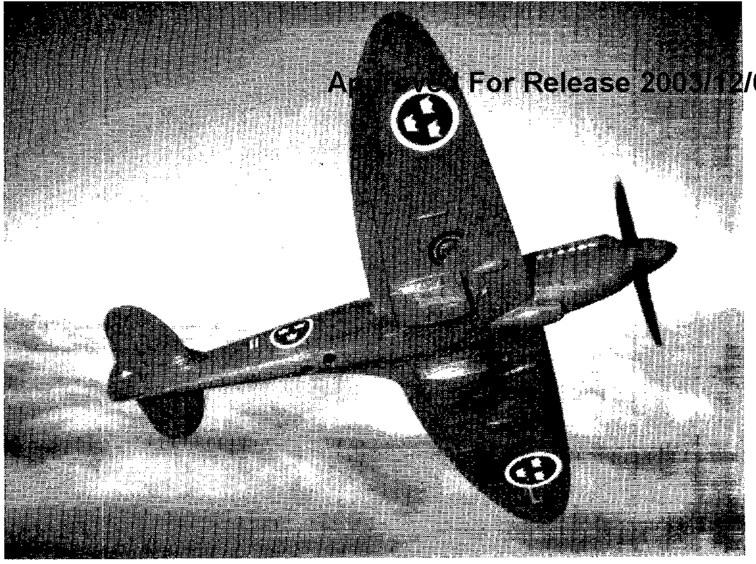
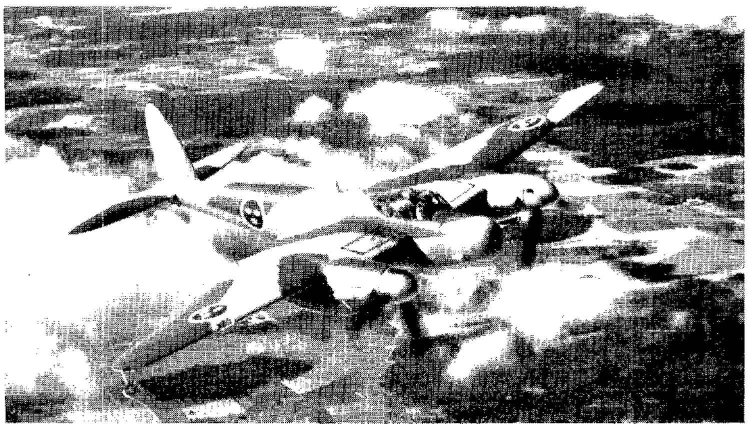
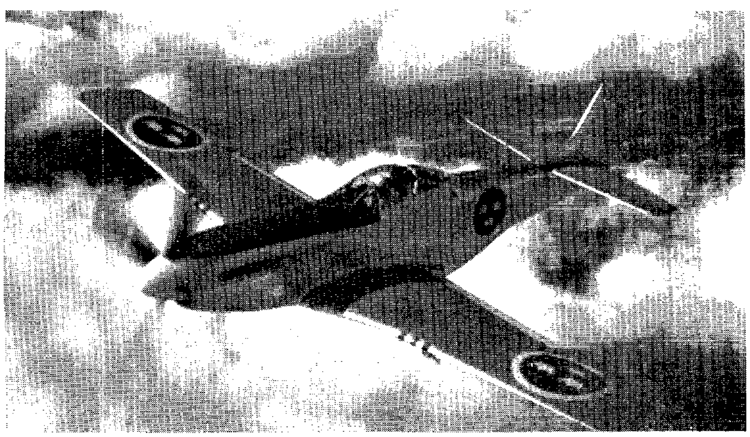


Photo reconnaissance is carried out by Spitfires Mk 19 (S 31). Swedish Air Force designation within brackets



The de Havilland Mosquito Mk 19 (J 30) for night fighting purposes



During and after the war a number of Mustangs (J 26) were purchased from the U. S. Air Force

THE ROYAL SWE

A REVIEW BY THE SWEDISH AIR FORCE

On the occasion of the 1949 parliament's decision that a certain strengthening of Sweden's fighter units should be undertaken, the prime minister made the following statement: "The air force with its high degree of preparedness and great flexibility may be regarded as our first line of defence, particularly in the event of a surprise attack on our country. Strong reasons exist, therefore, for the progressive strengthening of the Air Force. Moreover, a well-developed air arm is also in a position to provide increased protection for our home district and improve the army's and navy's fighting strength".

The foregoing statement not only discloses a clear recognition of the lessons to be learnt from the second world war but it also contains in a nutshell particulars of the tasks awaiting our air force which since 1926 has constituted an independent branch of defence, side by side with the army and navy. The Swedish fighting forces are obviously organized for defensive purposes, that is to say, the defence of Swedish territory. Consequently, chief stress has been placed in the Air Force on the fighter defence. The peacetime organization comprises ten day fighter-, one night fighter-, four attack- and approximately two reconnaissance wings.

The tasks alloted to the different types of aircraft may be summarized briefly as follows:

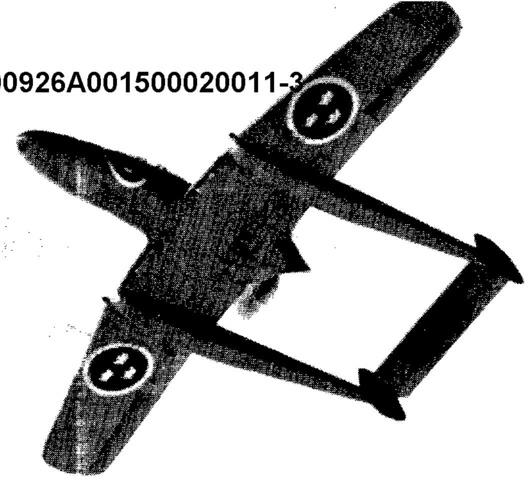
Day fighters are to be set in to meet air attacks against home district and communications, against robot weapons of the V1-type and against transport planes carrying air-borne troops. In the event of an invasion across the borders and coast lines the fighter aircraft must provide protection for their own troops and vessels. In addition, they must protect attack planes when carrying out low-level attacks against aircraft bases and warships, prevent enemy air reconnaissance and intercept enemy forces attempting to fly over Swedish territory, while carrying out neutrality patrols. The task of attack planes is to attack advanced air- and robot bases and destroy the enemy's communications on land and sea.

In the event of an invasion, moreover, the attack planes must fight the ground forces, sea transports and troops.

The flying personnel of the Air Force is to consist of officers and pilots engaged for short periods. The basic Air Force training lasts for one year and takes place at a flying school common to the whole Air Force, located at Ljungbyhed (Southern Sweden). The subsequent training is carried out at the headquarters of the diffe-

DISH AIR FORCE

PRESS OFFICER, MAJOR SVEN HOLMBERG

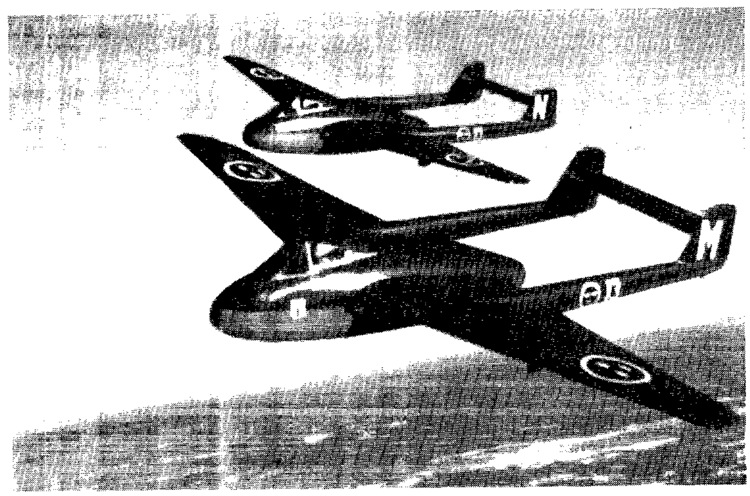


The Saab-21A fighter and attack aircraft is the predecessor of the Saab-21R jet-fighter

rent wings, and in addition, cadets are trained at the Cadet Flying School in Uppsala (Central Sweden). Advanced training for the officers is given at the Air Force College, and consists of a general course followed by advanced courses. The general course which extends over one year is obligatory.

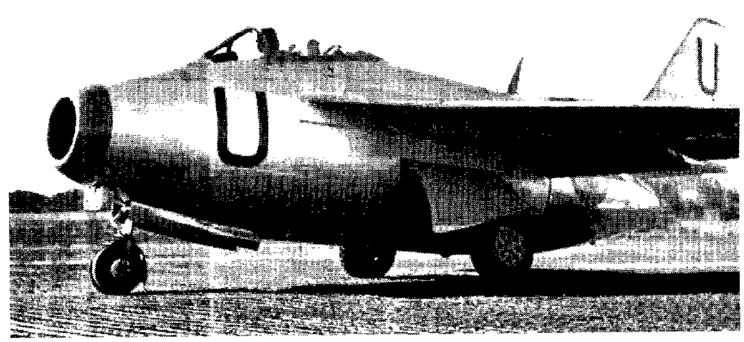
Lieutenant General B. G. Nordenskiöld is at the head of the Air Force as its chief, and has the Air Staff and Air Board at his disposal, amongst other units. The tasks of the Air Staff are of an operative-, organizing and instructive nature, whereas the Air Board deals with technical-, economic and legal matters.

Saab is in close contact with the Air Force, and in cooperation with the Air Board, designs, tests and manufactures aircraft. In a similar manner the work of producing aero engines is alloted to the Svenska Flygmotor A.B. in Trollhättan (Western Sweden).



The de Havilland Vampire (J 28) resembles slightly the Saab-21A and the Saab-21R

The aircraft of its own design which Saab has handed over to the Air Force hitherto are the B 17, a light single-engine attack plane which was also produced in a reconnaissance version. This plane has now been withdrawn from service almost entirely and replaced by the B 18, T 18 and A 21, all supplied by Saab. The B 18 and T 18 are twin-engined attack planes carrying bombs, rockets and cannon. The A 21 and its fighter version J 21 have pusher propellers which permit an equally good view to that obtained in a jet plane. The J 21R is also in production, and in this type the piston engine of the J 21 is replaced by a Goblin III jet engine. The plane will partially replace the J 22, a small fighter aircraft designed and produced by the Air Force. The engines for the J 21R are manufactured under licence by the Svenska Flygmotor A.B.

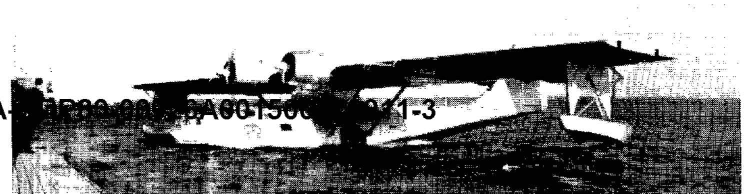


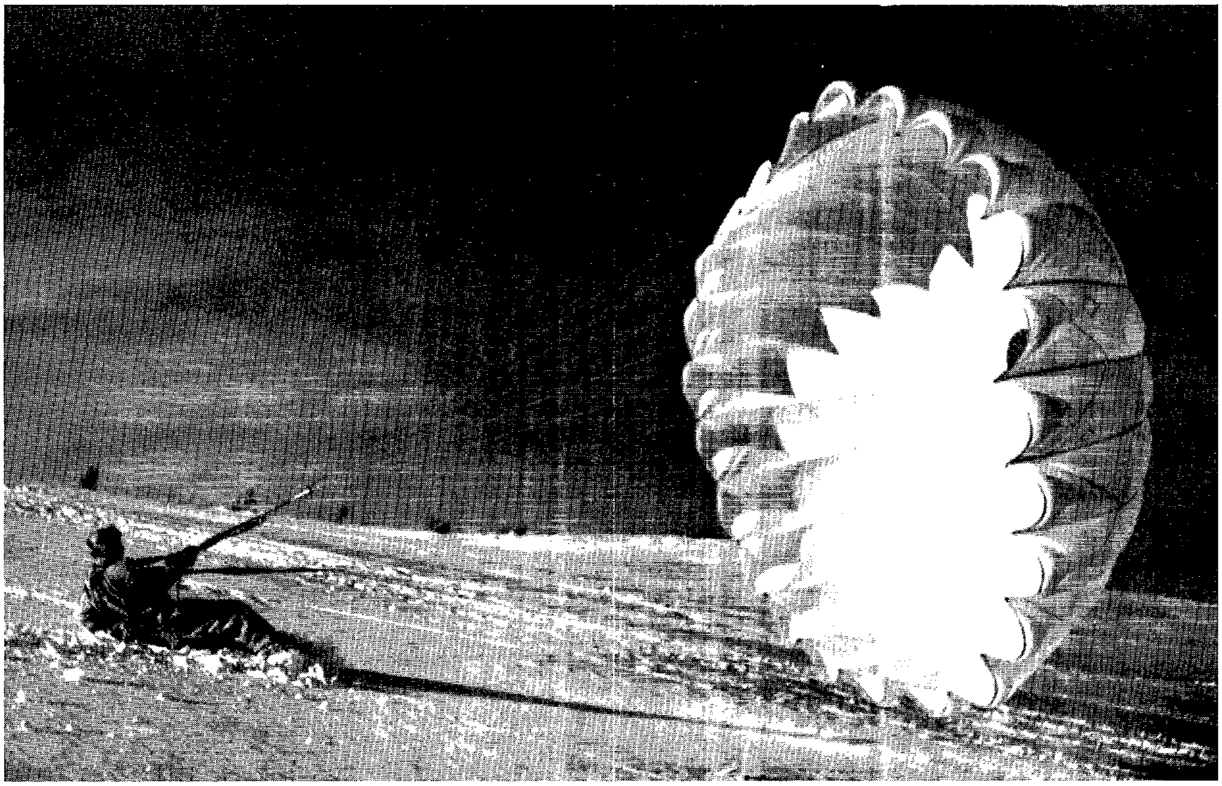
Sweden's newest and fastest military aircraft, the Saab-29 jet-fighter

The J 29 is being tested by Saab at the present time, and it is anticipated that this will be a very up-to-date fighter with a maximum speed exceeding 620 m. p. h. (1,000 km/h).

The following military planes of foreign manufacturing are to be found in the Swedish Air Force, N. A. Mustang (J 26), de Havilland Vampire in two versions (J 28A and J 28B), D. H. Mosquito (J 30), the night fighter and Supermarine Spitfire (S 31), photo reconnaissance plane. The Catalina (Tp 47) amphibian is used for sea rescue work.

Our country did not take part in the world war but it has nevertheless been possible for us to avail ourselves of the experience gained during the war, and we have therefore been able to build up a strong air force organized and equipped on up-to-date lines.





Parachute Jumping and Emergency Landing in Mountainous Country

In this article Major Sven Holmberg, Swedish Air Force Press Officer, describes some experiences from the winter trials of the Swedish Air Force.

To most of us, thoughts of the mountains in wintertime bring back pleasant memories of skiing trips, sunshine, snow and good times generally. For members of the Royal Swedish Air Force, however, the mountainous country has very different associations too. It is a desolate, bare and cold district covering about one-quarter of Sweden, in which an emergency landing or a parachute jump may produce situations which cannot be faced successfully without training, good condition and suitable equipment.

For many years past the Swedish Air Force has devoted keen attention to the problem presented by flights over our mountain districts in wintertime. Even during the first year's instruction in flight, pupils are taken to the North of Sweden in order to familiarize them with the mountains and snow conditions and learn the steps a flyer must take in the event of a forced landing in these districts.

We have now reached a point at which we can say that we know what equipment should be carried during flights over the mountains in winter and what the personnel is capable of enduring. This knowledge has been acquired from the experience gained during actual emergency landings and comprehensive trials in which a large part of the Air Force personnel have participated and have thus increased our chances of coming through safely when exposed to conditions of cold, snow, mountain storms and desolate surroundings.

The emergency equipment which a flyer has with him when bailing out must, of course, be carried in his pockets or be attached to his person in some suitable manner. Obviously, strict rationing is essential and all available space must be utilized to the best advantage, in addition to which all material must be suitably packed. One important item consists of snowshoes. These are made in a collapsible form and are packed, together with an under-suit and a wooden board on the inside of the parachute seat. The wooden board which is shod with steel is employed as a snow shovel. Emergency rations must also be carried, and these consist of a tin box containing chocolate, caramels, sweets, coffee, grape-sugar tablets, cigarettes, etc. A wax light (igloo light), meta spirit cooker, emergency signalling apparatus and so on must likewise be included in the flyer's equipment.

In the aircraft itself further equipment is included such as skis, packing material, provisions, cooking-, heating- and service equipment, tools, clothing, etc. Thus, in the event of a plane having to make a forced landing on a mountain lake, for example, the chances for the crew to bear the rigorous conditions encountered in mountainous country are appreciably greater than in the case of a person who is obliged to make a parachute landing.

The Air Force's emergency equipment has been tried out in the course of a fortnight's expedition to the Jämtland mountains (Northern Sweden) during the past winter. The purpose of the trials was both to obtain a final opinion as to the suitability and employment of the material and to obtain a conception of the endurance of the personnel.

Five persons participating in the trials were assumed to have made parachute jumps over the bare mountainside. Of these, one was required to remain at the point of landing for two-and-a-half days. The second was required to find his way to wooded country and maintain himself there for two and-a-half days. The task of the third was to endeavour to find his way to an inhabited region the position of which was known to him. The two remaining persons

Snowshoes were an invaluable aid when marching over desolate spaces

After landing from a Saab-B18 an emergency bivouac has been set up, using the parachute as a tent. A part of the enging cowling which served as a sledge during transport is here used as a fireplace

The trials were strenuous and realistic. A medical patrol on its morning rounds is here seen assisting a participant in the test from a grotto dug in a snowdrift. (Copyright for all illustrations in this article: Text & Bilder, Stockholm)

Careful medical examinations were made both during and after the trials. In the upper picture the skin temperature is being taken by the medical patrol. Below, a condition test is being carried out after a sojourn of 50 hours in the mountains

were to proceed on snowshoes for two-and-a-half days after their simulated parachute jumps.

Two aircraft, a Vampire and a Saab-B18, the latter with a crew of two, were also assumed to have made a forced landing without injury to the crew. The crew of the Saab-18 remained beside their plane for two days, and then began to walk towards an inhabited region which they reached on the sixth day. The pilot of the Vampire remained near his plane for two-and-a-half days and was then rescued.

The trials were strenous and during their progress the health of the participants was kept under observation by a medical officer who made the rounds in the morning and evening. Furthermore, everyone taking part had to undergo an examination for condition both before and after the trials.

Generally speaking, the body temperature was below the normal figures and in one case it was so low that the trial had to be interrupted for reasons of safety. One interesting point noted was that an odour of acetone could be observed in the breath in several instances. This is a sign of incomplete fat combustion and indicates hunger. In most cases, however, a sensation of hunger was not particularly marked by the participants in the test in spite of the fact that the provisions consumed per day by the three persons who took the least nourishment consisted on the average of:

½ a cake of chocolate (1 ounce, 25 g)
2½ grape-sugar tablets
4 caramels

Mild winter weather prevailed during the greater part of the test period with temperatures round about freezing-point, and with hard winds frequently accompanied by rain mixed with snow. At night-time the temperature usually fell below zero. The previous experience of mountaineering experts that moisture is generally harder to endure than cold was confirmed by all the participants.

By intention, officers whose condition and mountaineering experience varied considerably were selected for the trials. In this way it was considered that a representative average of the flying personnel had been tested. Various forms of night quarters were employed, for example:

Snow caves formed in snowdrifts on the bare mountainside and in the forest
snowcaves dug out of the ground
tents of parachute material
igloos of different kinds

The universal experience showed that it pays to devote careful attention to the construction of an emergency bivouac which is sufficiently spacious and leakproof, since it will offer considerably enchanced possibilities of sleep and rest.

A good emergency equipment will not suffice in itself, however. It is vitally important also that the flyers should be suitably clothed. Low shoes and thin underclothes constitute an extremely unsuitable form of clothing for persons having to endure cold, moisture and wind. On the conclusion of the tests one of the participants remarked:

"Now I know a chap who wont fly in wintertime again without an extra pair of gloves."

The following points are of general interest:

The parachute when correctly employed offers excellent protection against cold.

It is very important to provide protection against moisture. It is of less importance if the underclothes are wet when a dry and warm garment is available which can be worn over them.

Contd. on the third page of the cover

The Scandia's Control- and Hydraulic System

by

Torsten Bråge, Controls and Hydraulical Engineer

Control system

The control surfaces of the Scandia are constructed throughout in the conventional manner, and consist of a metal framework covered with fabric. Forces are transmitted from the control members to the control surfaces through bellcranks, cables and push-rods, and as on commercial aircraft in general, the control system of the plane is provided with dual controls for all control surfaces.

The control column for elevation and banking, which in most other planes is somewhat bulky, has been replaced in the Scandia by a much more flexible arrangement. In this case the steering wheel is connected through a push rod to a control shaft in the nose of the aircraft. The push rod which transmits push and pull as well as torsional forces, passes through the lower part of the instrument panel where it is supported in a self-aligning, self-lubricating bearing. With this arrangement space is available for the purpose of operating the rudder pedals which can be conveniently adjusted fore and aft and are mounted on a common shaft.

Elevation- and turning control is effected from the steering wheel-control shaft and rudder pedals by means of cables attached to bellcranks which are mounted on torque tubes at the rudder. These torque tubes are fixed to the stabilizer and fin and constitute supports for the control surfaces which can thus be readily exchanged without necessitating the removal of the cables or even altering their rigging in any way.

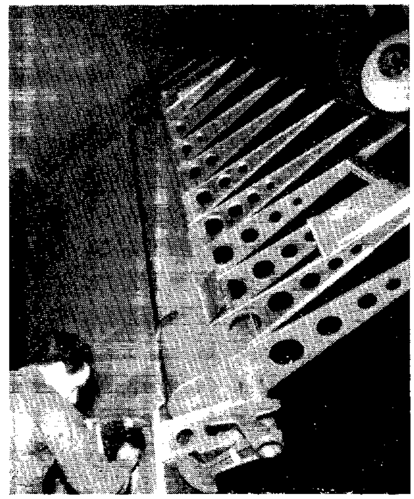
For banking control the torque is transmitted from the steering wheel via the push rod torque tube through a universal joint to a chain transmission which is connected to a cable drum on the rear spar in the wing centre section by a continous cable system. From the cable drum the cables run to a bellcrank in each outer wing

Mr. Torsten Bråge

from where the movement is finally transmitted to the ailerons by means of push-rods. The outer wing flaps are connected by push-rods to the aileron mechanism in such a way that when the wing flaps are deflected they produce a deflecting action on the ailerons without affecting the banking effect.

All control surfaces are provided with tabs, operated in the usual manner by cables, screw mechanisms and push-rods. The controls for the trim tabs are mounted on the control pedestal and are so designed and located that their adjustment corresponds to the movements of the aircraft in the air. For example, if the tail of the plane is heavy, the elevator trim wheel is turned forward until the nose is lowered to the correct flying position. Should the right wing dip, the aileron trim knob is turned to the left until the position is corrected and in the event of the plane yawing to the left, the rudder trim crank is turned to the right to bring the plane onto a straight course. All trimming adjustments are mechanically indicated on the control pedestal adjacent to the control devices.

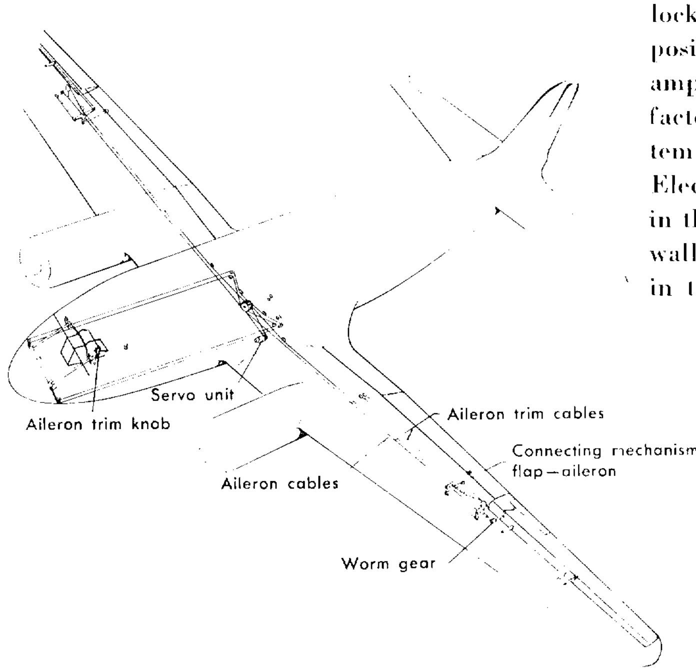
The entire control system can be locked at a central point from the first pilot's seat by means of a handle, which renders the use of blocking devices at the control surfaces unnecessary. The control system also includes a gyropilot installation, the servo-motors of which operate all control surfaces. This equipment was described in an article on the Scandia's electrical installation, contained in No. 6 of Saab Sonics. It may be mentioned here, however, that the installation comprises three controlling motors — one for each control surface. Of these, the motors controlling the elevators and rudder are located abaft the rear cargo compartments and are coupled by cables to the primary control system. The motor controlling the ailerons is mounted on the rear spar in the wing centre section and is connected to the aileron control through the cable drum referred to previously.

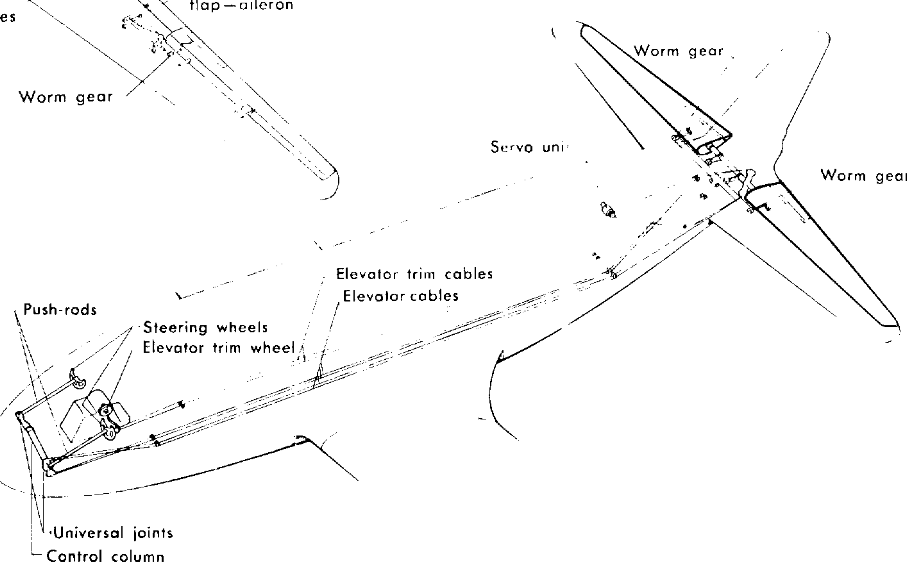


The metal frame of the rudder before it is fabric-covered

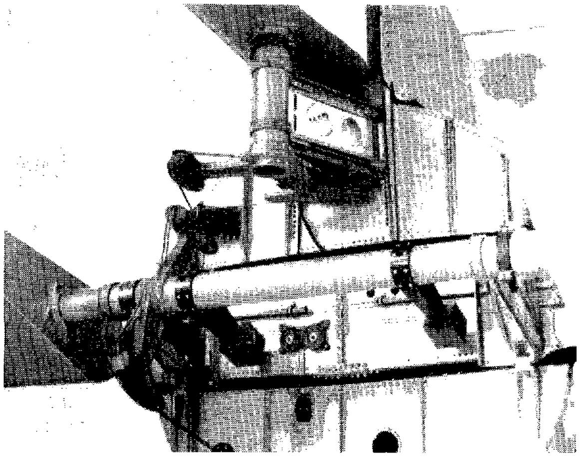
The Hydraulic System

which is a medium pressure system, is fed by two engine-driven gear pumps, one of which is mounted on each engine. The pumps are connected to the system in such a way that one pump alone can provide the supply. Oil under pressure is conveyed to the pumps through lines from a reservoir located in the accessory locker in the flight compartment. The elevated position of the reservoir in conjunction with the amply dimensioned suction line ensure a satisfactory oil flow to the pumps, even at very low temperatures and when flying at high altitudes. Electrically operated shut-off valves are fitted in the suction lines immediately behind the fire wall in the nacelles. Should a fire break out in the power plant, these valves can be closed





The principle for the aileron system (above) and the elevator system (right)



On the torque tubes at the control surface the bell cranks are mounted, to which the cables are attached

from the pilot's seat, and the conflagration is prevented from spreading via the hydraulic system. In the event of both engine pumps breaking down, a hand-operated auxiliary pump is provided in the flight compartment as an additional safety measure.

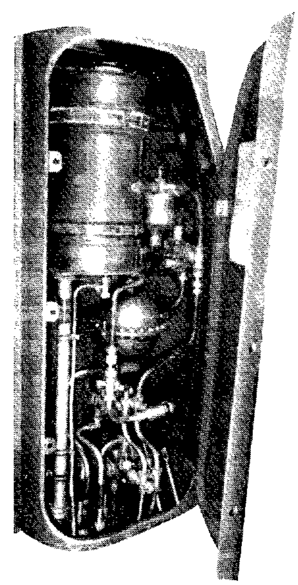
This auxiliary pump is one of the few hydraulic units that is not installed in the accessory locker in the flight compartment. Apart from the main tank, this locker contains the pressure regulator, the accumulator, the relief valve, the filter, the selector valve for the landing gear and the pre-selector valve for the wing flaps. In consequence of the concentrated location of this equipment the hydraulic apparatus is conveniently accessible for inspection and control, and it is even possible to carry out repairs on the apparatus during flight when necessary. Thus, this accessory locker may be regarded as the heart of the hydraulic system and a network of lines branches out from it to the various units in the aircraft which are operated hydraulically, such as the landing gear, the wing flaps, the wheel brakes and, in some cases, the operating cylinder for the nose wheel steering gear.

The working pressure of the hydraulic system is 70 atmospheres and it is regulated by an entirely automatic pressure regulator which also connects up the idling circuit of the system so that no oil can circulate through the lines and apparatus of the working units that are not in operation.

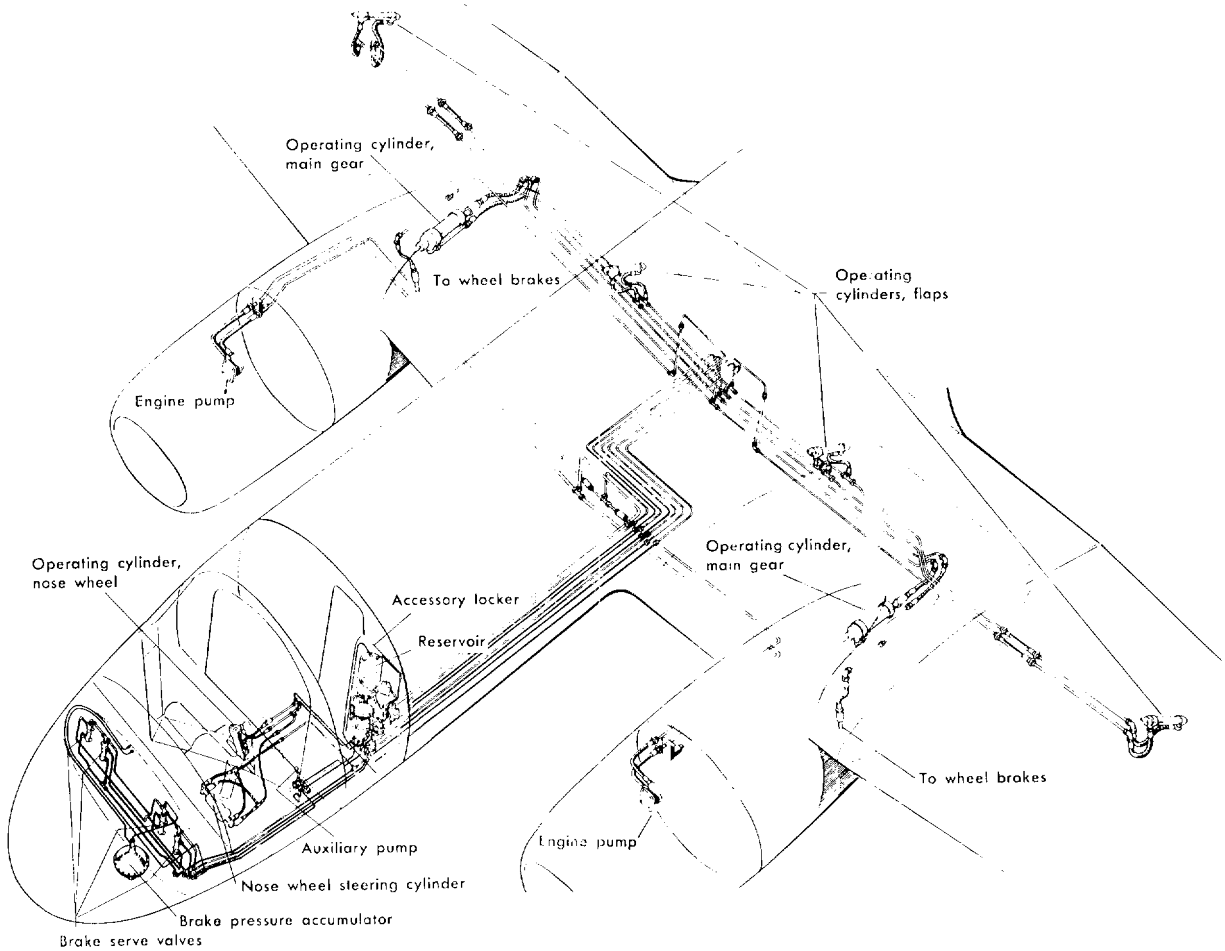
The Landing Gear and Wing Flaps are operated by hydraulic cylinders, to which the oil supply is regulated by selector valves, one for the landing gear and one for the flaps. The valves are regulated by levers from the control pedestal and the movements are transmitted by cables and rods. The landing gear lever is provided with a special blocking device to prevent unintentional retraction of the gear. In order to reduce speed of the extension of the landing gear a restriction valve is fitted in the retractor line (return line for extension) for each of the three landing strut cylinders. As has been described in previous articles in Saab Sonics, it is also possible to extend the landing gear if, for any reason, the pressure fails in the hydraulic system. The gear is retracted forwards and upwards, consequently its own weight assisted by the force of the air current will suffice to extend it.

The wing flaps are divided into four sections, each section being equipped with a hydraulic cylinder. The sections are mechanically synchronized so that the four flaps always take up the same positions in relation to one another. The actuating valve for the flaps works as a pre-selector, that is to say, the position of the flaps can be determined in advance by means of a lever on the control pedestal. If it is desired to deflect the flaps 20° for example, it is only necessary to set the regulator directly over the index indicating a deflection of 20°, whereupon the flaps will move to that position automatically.

If for any reason the hydraulic pressure happens to be higher than the pressure at which the pressure regulator cuts out, the main safety valve comes into operation, whilst any rapid changes in the normal pressure are compensated



The accessory locker in the flight compartment the central point of the hydraulic system



Diagrammatic view of the hydraulic system showing the principal parts

by a pressure accumulator. Safety valves are also fitted in the actuating valves for the landing gear and flaps. With this arrangement the quantity of oil contained in the lines can expand without causing damage to the lines or cylinders.

A filter of the gap type is fitted in the return line immediately in front of the reservoir.

Braking System and Nose Wheel Steering

The braking system, which is separated from the main system by a double check valve, consists of two main wheel brakes of the single disc type. It is connected up in such a way that the left wheel is braked by a valve actuated by the left brake pedal, the right wheel being braked by the right pedal. This applies both to the first and co-pilot's brake pedals. If the pressure in the hydraulic system fails entirely, the brake system can still be operated by a special pressure accumulator in the system.

The main- and braking systems are each provided with a pressure gauge, mounted on the instrument panel, on which the pressure in the two systems can be read.

The cylinder for the nose wheel control is a combined anti-shimmy device and steering cylinder which is so connected to the hydraulic system that it can only be operated when the landing gear has been extended. Combined steering and anti shimmying is effected by means of a special valve system built into the cylinder. For steering purposes the valve mechanism is operated by a hand-wheel from the first pilot's seat and the power is transmitted by a chain and cables.

The hydraulic installation in the Scandia has been designed with a view to obtaining a system offering maximum reliability and simplicity, and one requiring a minimum of service, whilst all vital parts are readily accessible for inspection.

SKF

Mr. Erland Bratt

A series of articles will be published in Saab Sonics introducing some of Saab's numerous sub-contractors. A beginning is made here with the SKF, Aktiebolaget Svenska Kullagerfabriken, of Gothenburg. The writer of the article is Mr. Erland Bratt.

An ancient principle with a modern application

When our forefathers first conceived the idea in prehistoric times of placing tree-trunks under a block of stone in order to cause the latter to roll instead of dragging it, they replaced sliding friction by the very much lower form of rolling friction. The same principle is applied to-day by the engineer who fits ball or roller bearings in a machine. Ball bearings and roller bearings — which in modern terminology are referred to jointly as rolling bearings — have exercised a considerable influence on the development of many forms of machines which are now indispensible to our daily existence. A number of these, such as motor-cars and aeroplanes, are only conceivable thanks to the use of rolling bearings. In practically all branches of engineering, moreover, such bearings contribute to satisfactory economic results owing to their light running, reliable operation, saving of lubricants and numerous other advantages. It is no overstatement, therefore, to say that they occupy a key position in modern industrial production.

A development in step with the times

Technical and economic development take place rapidly nowadays. The SKF — Aktiebolaget Svenska Kullagerfabriken — was founded in the year 1907 by Sven Wingquist, and the firm's first factory consisted of a small and insignificant workshop in which 12 workmen and 3 employees were engaged. At the present day, some forty years later, the SKF has a staff of approximately 30,000 people and more than a dozen factories at home and abroad. And the expansion of the firm still continues; large-scale factory extensions are now taking place both in Gothenburg and abroad.

In the year 1912 the SKF erected its first research laboratory at Gothenburg. As the result of the work carried out here it became obvious that the manufacture of ball bearings called for strict control in the production of the steel, right from the ore stage — a control which the SKF found it desirable to exercise themselves. For this reason in 1916 the SKF purchased Hofors Bruk with the mines and forests belonging to it. These ironworks, the beginnings of which go back some 300 years, have since become one of the most up-to-date high-grade steel works in the world with an annual capacity of 120,000 tons of ingots.

Sales and customer service go hand in hand

The SKF built up a widely ramified sales organization at an early stage and now has over 200 sales offices in some 60 different countries. In addition, stocks of SKF-bearings are held by

Figs. 1 and 2 (below). On the left, a part of the SKF's factory plant in Gothenburg. The map of the world on the right indicates the places in which the SKF has representatives

more than 10,000 retailers. From these depots all the more usual types of bearings, at least, can as a rule be delivered without long and time consuming overseas transports.

The sale of rolling bearings can scarcely be regarded as similar to the sale of any other articles. Operating conditions and machine designs are of infinite variety, and although the rolling bearing itself is a machine part requiring little attention, it is necessary when delivering the bearings to supply the customer with instructions for their installation and maintenance in order to enable him to obtain full value for his money. This technical service is considerably facilitated by the fact that the SKF has now established its own sales companies in most countries with a developed industry. In each of some 40 SKF-companies a staff of specially trained designers and fitters is responsible for this technical service. The designers assist purchasers in the choice of bearings, prepare schemes for the installation of the bearings and assist in the solution of all bearing problems arising. The services of the fitters are placed at the disposal of customers for carrying out or supervising the actual work of mounting the bearings. The SKF attaches very great importance to this technical service. To assist in the work an organized and regular exchange of technical experience takes place between the SKF offices in different countries, and Swedish SKF engineers stationed abroad usually travel home to Gothenburg after a few years' service in order to be coached in the latest advances made in bearing engineering.

Research and progress

When the SKF first started its activities a number of the bearing types now customarily employed were already known but ideas concerning many of their properties were somewhat vague. It was assumed, for example, that there was a maximum load for every type and size of bearing which the latter was capable of supporting for any length of time, and on the other hand, that the bearing would be rapidly destroyed by fatigue if this maximum load were exceeded. Loading figures of this kind are to be found in all ball bearings catalogues of that day, but the SKF soon found cause to doubt the accuracy of such information. In the SKF's central laboratory in Gothenburg and in the laboratories that have later been installed by the SKF in its other factories fatigue tests were carried on day and night then as now with bearings of different types and designs, and the test results showed that the life of a bearing is dependent in a definite manner upon the load on the bearing. The SKF was now able to introduce figures obtained empirically in its catalogues concerning the relation between load-carrying capacity and life, and this method of indicating carrying capacity has now been adopted by practically all ball bearing manufacturers.

The pioneer work comprised far more than this however. The important questions concerning the carrying capacity of bearings under variable loads, their elastic properties and static carrying capacity, to mention a few examples only, found their solution in the work of the SKF, and a year ago the firm was able to publish a new general method for the determination of the dynamic carrying capacity by theoretical means, a procedure which could only be carried out previously by long and comprehensive tests. This method, which represents the latest fruit from the tree of ball bearing knowledge, yields results which practically coincide with the empirical figures referred to above.

The material and the design are not, of course, the sole factors that influence the satisfactory functioning of the bearings. Their accurate dimensions and running as well as the dimensions of shafts and bearing housings likewise play an important part and the SKF consequently devotes very careful attention to gauging methods, tolerances and fits. Tools and methods for mounting and lubricating bearings have also been devised by the efforts of the SKF.

The right bearing in the right place

During the early years following the foundation of the firm, the SKF was mainly engaged on the manufacture of double-row self-aligning ball bearings. This type of bearing finds application for a great variety of purposes, with the result that the SKF established contact with numerous different branches of industry and thus had its attention directed to their widely varying requirements. In order to meet these requirements the SKF subsequently began to produce other types of bearings. Many new bearings were designed by the firm, such as the self-aligning spherical radial roller bearing which possesses a greater radial carrying capacity than any other type of bearing, in addition to its great thrust carrying capacity; certain types of

Fig. 3. Measuring the track diameter in the inner rings of single-row ball bearings

the cylindrical roller bearing which are suitable for heavy radial loads at high speeds; the self-aligning spherical thrust roller bearing which can also support heavy axial loads at high speeds, and so on. Other types of bearings such as the single-row and double-row deep groove ball bearings, taper roller bearings and thrust ball bearings are of foreign origin, but the SKF has included them in its manufacturing program and has introduced notable improvements in certain cases. The combined production of the SKF factories constitutes the largest selection of bearing types that any manufacturer is in a position to offer.

Important though it is from a technical standpoint to supply different types of bearings for different applications, it is of equal importance from an economic point of view to employ the same bearings for the same purpose. If the SKF had supplied all the numerous forms of bearings called for by customers in the course of time, the number of types and sizes would have risen in the Gothenburg works alone to more than a quarter of a million. Customers would have been obliged to pay for an extremely uneconomic form of production and the bearings would have been difficult to replace. The SKF has taken the initiative in the international standardization of rolling bearings, however, and has been the primary driving force in this work. Furthermore, the firm has, of course, proceeded with its own internal standardization. This has rendered it possible to reduce the number of different forms to about 8000 — a number that is entirely adequate to meet present technical requirements — and three-quarters of the bearings have dimensions which are in accordance with one or other of the 1820 international standard sizes and can, therefore, be exchanged irrespective of their manufacture.

The great majority of the SKF's products consist of rolling bearings and accessories. The manufacturing program also includes a multitude of other articles, however, such as balls and rollers for various purposes, tailstock live centres, measuring apparatus and gauges, ground taps and dies, ball bearing wheels and castors, conveyor, rollers, rope sheaves, oil-injection couplings, lubricating apparatus and lubricants, tube blanks of machine steel, centerless ground shafts, cast-iron blanks, etc.

Products must run the gauntlet between the inspectors

The manufacturing process for a ball bearing of medium size may be described briefly as follows:

The outer rings and inner rings are turned from tubing in multispindle automatic lathes. A further turning operation follows in which the width is adjusted and the tracks formed.

After being heated up in automatic furnaces the rings are hardened in oil, tempered and cleaned. This is followed by the grinding of the sides of the rings to produce the desired width, external grinding in centerless machines, the grinding of the bore in the inner ring and finally, the grinding of the ball tracks in both rings. The tracks are polished and the rings are then ready for assembly.

The balls are made of drawn wire. The wire is cut in presses to pieces of the correct size which are shaped into ball blanks between two pressing dies. In the subsequent operations the fin formed by pressing is machined off and the balls are subjected to preliminary grinding, hardening and tempering. After a further series of grinding and tumbling operations the balls are finally polished. Grinding operations are carried out in machines fitted with a rotary grinding wheel and a stationary cast-iron disc between which the balls roll in concentric grooves. Here the balls are caused to change their axes of rotation continuously with the result that they are ground over their entire surface.

The ball cages are pressed out from steel plate or are made of solid material.

The finished rings, balls and ball cages are then assembled to form a complete bearing.

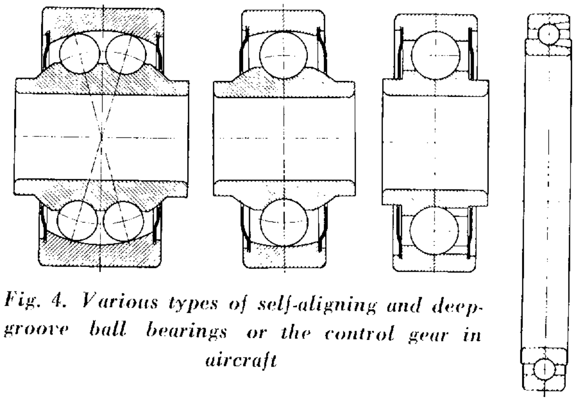


Fig. 4. Various types of self-aligning and deep-groove ball bearings or the control gear in aircraft

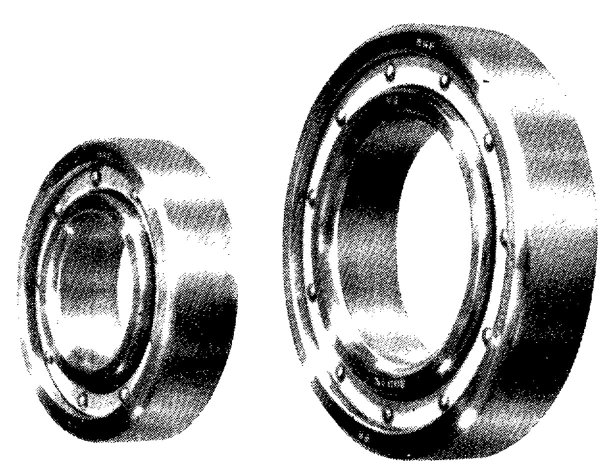


Fig. 5. Deep-groove ball bearing for the compressor of an aero-engine

In all stages of the production the ball-bearing technical section, the metallographic, measuring, physical and chemical sections of the SKF laboratories exercise a continuous inspection, and if we restrict ourselves to work taking place in the ball-bearing factory alone, we find that each one of the 40-odd processes through which a medium-sized ball bearing has to pass is followed by a checking operation, notwithstanding which the finished bearing has to undergo a very stringent final inspection. The total number of checking operations carried out on one and the same bearing thus amounts to about 70.

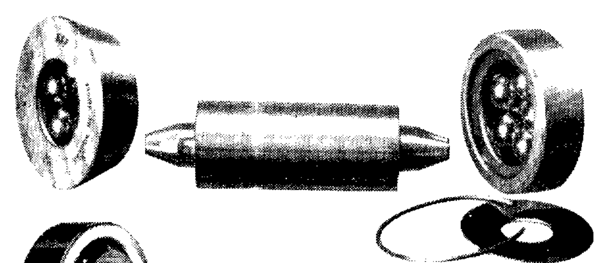
The bearing's carrying capacity, its interchangeability and the possibility of employing certain fits for mounting it — all these points depend upon the dimensional accuracy of its various parts. It is not surprising, therefore, that there are many checking operations, nor that checking occurs in several stages, one superimposed on the other as explained below.

The dimensions of the bearings are mainly checked by the inspection departments. Amongst the measuring instruments employed for this purpose, many are capable of giving readings in thousandths and even ten-thousandths of a millimetre. The measuring instruments and gauges are checked in turn by a special instrument calibrating department, and the gauge blocks employed by the calibrating department are finally checked by the measuring section of the central laboratory. The latter is equipped with an interference comparator, an apparatus by means of which, through the interference of light, it is possible to determine longitudinal dimensions in relation to the wave-length of the light from a given line in the spectrum. With the help of the interference comparator a gauge can be measured with an accuracy of about ± 20-millionths of a millimetre.

Which types of bearings are employed in aeroplanes?

The bearings used in aeroplanes often run under very special conditions and sometimes, where only a very limited space is available for example, the design of the bearing must be intimately adapted to the parts to be supported. The result of this has been that, side by side with the standard bearings, numerous bearings with special dimensions and bearings with different surface finishes, dimensional and running accuracy, etc, have been produced.

Ball bearings amounting to three- and four-figure numbers are employed in the control gear of an aeroplane and some of these bearings have special dimensions, for which reason the SKF has designed certain "special standard series". It is characteristic of the bearings that the inner rings are constructed somewhat wider than the outer rings for technical reasons connected with their fitting, and that the bearings are usually provided with shields, that they are filled with a special grease which does not stiffen at low temperatures, and that they are treated to prevent corrosion. The load on the bearings is usually static, and the bearings are



Figs. 6 (top) and 7 (left). Some rotor bearings for gyroscopic instruments only required to execute intermittent rotary movements. The demands made with respect to the surface finish of the tracks, the dimensional and running accuracy are, therefore, by no means exceptional. Fig. 4 shows some types of single- and double-row self-aligning ball bearings and deep-groove ball bearings for the control gear.

In some respects, the conditions are entirely different for engine bearings. Although it is possible to employ standard bearings for the engines also in many cases, the demands in connection with specially smooth running, high dynamic carrying capacity, dimensional stability, etc, frequently render it necessary to introduce special forms of manufacture and inspection. Examples of bearings of the highest class may be seen in Fig. 5, in the form of deep-groove ball bearings for aero-engine compressors. These bearings are characterised by precision carried to extremes in every direction.

Finally, some rotor bearings for gyro-instruments are illustrated in Figs. 6 and 7. The former shows angular contact roller bearings of special design, the latter showing a single-row self-aligning ball bearing. The bearings were manufactured in accordance with special methods, which produce an extremely fine surface finish and accuracy of shape. The ovality in the taper roller ends shown in Fig. 6 amounts to a few ten-thousandths of a millimetre, and the eccentricity of the spherical ball bearing's inner ring is less than two thousandths of a millimetre. It is practically impossible to measure any lack of sphericity in the balls themselves.

Contd. from page 16 (Parachute Jumping)

It is advisable to remain at the plane if possible. The bodily supply of nourishment, like that included in the equipment, is limited. It should not be wasted, therefore, on energy-consuming, and possibly futile, marches through unknown territory. As a general rule it is preferable to devote one's efforts to the construction of a reasonably satisfactory bivouc and to signals which can be clearly distinguished from the air and by ground patrols.

To guide ground patrols it is a good plan to lay a star-shaped trail from the camping place, whilst air reconnaissance is facilitated by employing large signs. A cross is the best form of sign and a large cross with a clearly defined outline can be seen more readily from the air than a small one which is entirely filled in.

The trials could not reproduce an exact picture of actual conditions in one respect, namely, the psychical strain due to the uncertainty as to whether help will arrive in time, also the feeling of loneliness particularly during sleepness nights. Such feelings may, of course, be further increased by bodily injuries. By giving the flying personnel training in winter rescue work, however, the latter will gain an increased feeling of safety and selfconfidence which are useful assets for a flyer forced to land in a mountainous region where he has to make good with the scanty resources at his disposal.

U. D. C. 354.73:614.86(485)

Karlsson, J. G.: *The Flight Safety Service of Civil Aviation.* Saab Sonics no. 7 1919 p. 2—5.

The ground organization is arranged in accordance with the Chicago Convention. Organization of the flying safety service. Traffic control. Sweden has three flying safety districts. Communication service. The air service employs special telephone-, wire telegraph- and teleprinter communications. Permanent radio connections with numerous foreign airports. Independent and local meteorological stations. Synoptic weather maps are drawn up every three hours. Summary.

U. D. C. 623.746(485)

Brising, L.: *Some Aspects of the Design of Swedish Military Aircraft.* Saab Sonics no. 7 1949 p. 6—10.

The work on the design of a military aircraft occupies a working time corresponding to about half-a-million hours. Organization. Planning a time schedule. Swedish demands respecting constructional form. Selection of type. Design for series production. The most important point is good coordination enabling the time schedule to be adhered to.

U. D. C. 358.4(485)

Holmberg, S.: *The Royal Swedish Air Force.* Saab Sonics no. 7 1949 p. 12—13.

A general survey of the organization and duties of the Swedish Air Force.

U. D. C. 355.53

Holmberg, S.: *Parachute Jumping and Emergency Landing in Mountainous Country.* Saab Sonics no. 7 1949 p. 14—16.

Report on the Swedish Air Force trials in the winter of 1949 to determine the suitability of the emergency equipment and endurance of the personnel.

U. D. C. 629.138.5.014.6 Saab Scandia
621-82:629.138.5 Saab Scandia

Brâge, T.: *The Scandia's Control- and Hydraulic System.* Saab Sonics no. 7 1949 p 17—20.

Control gear. Control surfaces of conventional construction. The control column has been replaced by a more flexible arrangement. The control surfaces can be exchanged easily. The aileron control passes over a central cable drum on the wing rear spar. Deflection of the aileron control. Trimming tabs on all control surfaces. The whole control equipment can be locked at a central point from the pilot's seat. Gyropilot equipment. The hydraulic system is fed by engine-driven geared pumps. One pump alone can supply the system. A hand-operated auxiliary pump provided for additional safety. The accessory locker in the flight compartment is the central point for the system. Working pressure of the system 70 atmospheres. The oil does not circulate through working parts when they are out of operation. Landing gear and wing flaps. A blocking device prevents unintentional retraction of the landing gear. Reserve extension arrangement. The wing flaps consist of four mechanically coupled sections. Position of the flaps set by a pre-selector valve. Brake system can also be operated when the pressure in the hydraulic system fails. Nose wheel steering combined with anti shimmying device by a special valve system.

U. D. C. 621.822.7-9:621.775

Bratt, E.: *SKF.* Saab Sonics no. 7 1949 p. 21—24.

The principle of the roller bearing is ancient. The development of the SKF. Sales organization. Research. Load-carrying-and fatigue tests. The right bearing in the right place. Production under accurate inspection. Aircraft bearings are produced in special standard series. Special forms of manufacture are necessary for engine bearings.

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